Integrated Water Quality and Aquatic Communities Protocol – Wadeable Streams

Standard Operating Procedure (SOP) #12: Physical Habitat Characterization

Draft Version 1.0

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP details the activities associated with describing the physical habitat of the stream channel, riparian zone, and surrounding valley based on EPA EMAP protocols (Peck et al. 2006). In a broad sense, the physical habitat of a sample reach includes all those physical attributes that influence or provide sustenance to organisms within and next to the stream. All of these attributes may be directly or indirectly altered by anthropogenic activities. Nevertheless, their expected values tend to vary systematically with naturally occurring variation in stream size, drainage area, and overall gradient. Aquatic macrophytes, riparian vegetation, and large woody debris are included in this physical habitat assessment because of their role in modifying habitat structure and light inputs.

The first three procedures discussed in this SOP are to be completed for the entire sample reach. The remaining procedures are to be completed at each of the 11 cross-section transects. The order of procedures presented here is not necessarily the order that they should be performed. Field crews should determine the most efficient way to describe the physical habitat of a sample reach based upon the unique characteristics of each sample reach. In addition, procedures performed at each of the 11 cross-section transects described in this SOP require consistency and efficiency that are acquired through repetition. Crew members should be designated to complete and be specialized in these components of this SOP and adhere to these designations throughout the field season.

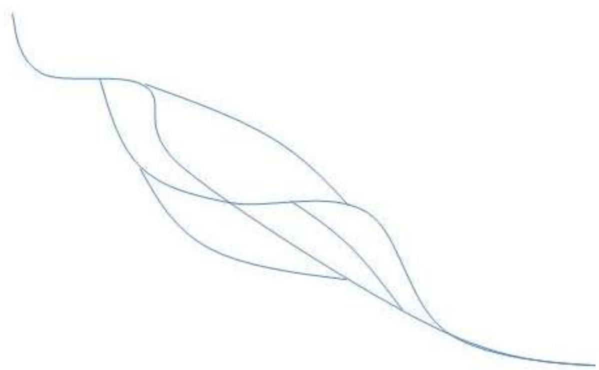
Channel Constraint Characterization

This procedure should only be completed after the crew member has observed the sample reach and surrounding valley in its entirety. On the Field Chemistry and Channel Constraint form, describe the various types of constraining features and the percentage of the sample reach that has constraining features on either bank. A constraining feature is any geological formation bordering the stream channel that would prevent water from leaving the channel, entering the surrounding flood plain, and possibly creating a new stream channel during a moderate sized flood event that would typically occur every 5-10 years.

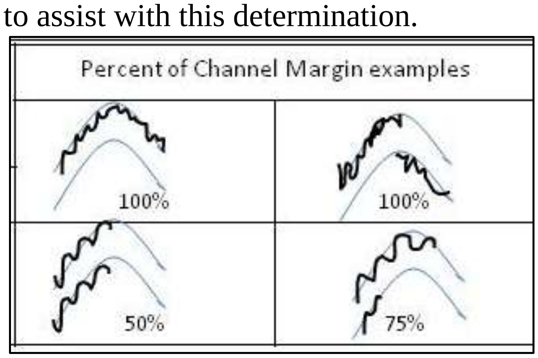
SOP #12: Physical Habitat Characterization (continued).

1. Under each of the categories ("Channel Pattern," "Channel Constraint," and "Constraining Features") listed on the datasheet, mark one category that best describes the surrounding geological features with an "X" in the box next to the category or using the picklist in the database. If more than one category of geological features is present within the sample reach, mark only the one that best describes the predominant feature.
    a. Channel Pattern:
        i. One channel, e.g., a single, dominant channel.
        ii. Anastomosing (complex) channel, a relatively long major channel, with minor channels branching and rejoining, as shown below:

        iii. Braided channel, where multiple short channels branch and rejoin, and shown below:



2. Record the percent of reach length with the side of the channel in contact with constraining features. If the feature is located on either bank (or both) along the sample reach, it counts toward the total percentage of the entire sample reach length. Use the below figure as a guide to assist with this determination.



3. Record the visually estimated average valley width of the valley surrounding the stream channel. If you are unable to see the valley borders due to surrounding vegetation or the expanse of the valley, mark the appropriate box with an "X" and record the reason you

were unable to make an accurate estimation in the "Comments" section of the datasheet or electronic form.

Torrent Evidence Characterization

This procedure should only be completed after the crew member has observed the sample reach and surrounding valley in its entirety. On the Torrent Evidence Assessment form, mark each of the 10 descriptive categories listed that describe the evidence of torrents that have occurred prior to the sampling date with an "X" in the box next to the category. In making the determinations, you may also look upstream or downstream of the reach. If more than one category of torrent evidence is present within the sample reach, mark all categories that apply. Take pictures of any evidence of torrents and describe these pictures in the "comments" section of the datasheet. If there is no evidence of torrential events within the sample reach, place an "X" next to the "No evidence of torrent" category. Note that if this category is marked, it should be the only category marked on the datasheet.

Large Woody Debris Tally

This procedure is intended to produce a quantitative estimate of the number, size, total volume, and distribution of large woody debris (LWD) within a sample reach. These estimates allow inference of the effect LWD has on the flow dynamics and habitat complexity of a stream. A piece of wood is considered LWD if:

1. Its location within the stream channel is at least partially in zones 1, 2, or 3 (Figure 1).

   AND
2. The diameter of small end of the main stem of the woody piece is at least 0.1 m.

   AND
3. The length of main stem of the woody piece is at least 1.5 m.

SOP #12: Physical Habitat Characterization (continued).

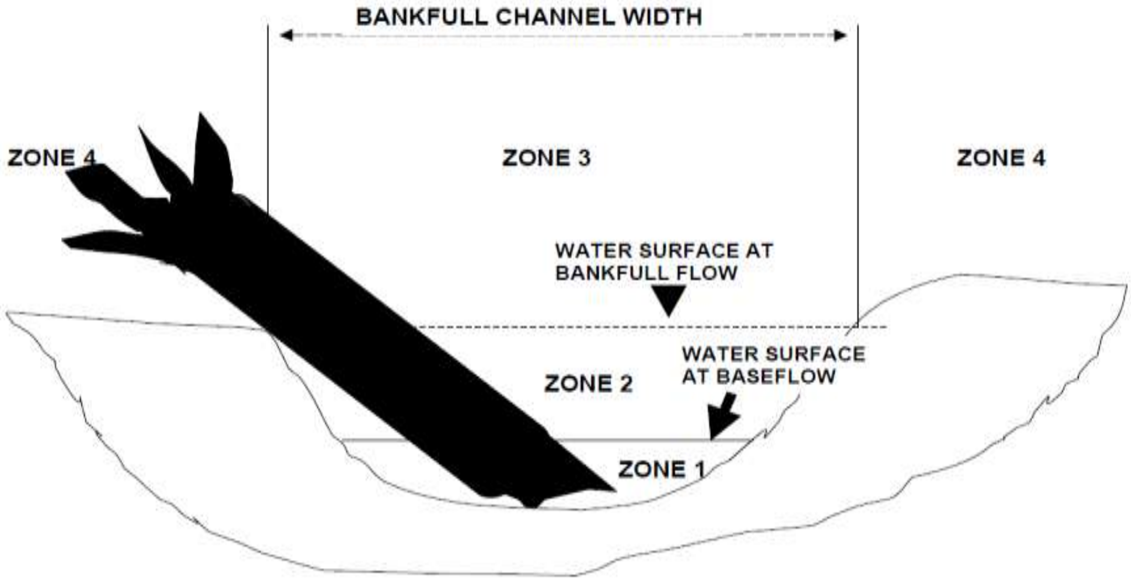


Figure 1. Large woody debris influence zones. (modified from Robison and Beschta 1990).

In order to reduce the time necessary for completion of this procedure, visual estimation of LWD dimensions is adequate. **However, at the beginning of the field season, use metric tape and Biltmore Sticks to measure various pieces of woody debris in order to calibrate the future visual estimates of crew members.** Many pieces of LWD are cylindrical and relatively linear in form, such as a fallen tree trunk, which makes visual estimation of their dimensions relatively easy. However, sometimes LWD is not cylindrical, so it has no clear "diameter." In these cases, estimate what the diameter would be for a cylindrical piece of wood with the same volume as the non-cylindrical piece in question.

1. Start at either end of the sample reach. Scan the stream segment between the first two cross-section transects for pieces of LWD.
2. For each cross-section transect pair in which there is LWD, record the number of pieces of LWD in the appropriate column on the datasheet. The larger boxes in the column are for counting pieces of LWD using tally marks; the smaller boxes are for the final numerical count of LWD pieces for that transect pair. If using the tablet PC, each tap in the category should autocount the pieces. The row in which the count is placed is based upon the location, diameter, and length classification of the LWD being observed. These classifications are:
    a. Location of LWD relative to bankfull height (as defined in "Bank Measurements" section of this SOP).
        i. <u>All or Part of Bankfull</u>- The piece of LWD is entirely or partly within the area that would be occupied by a bankfull discharge event (all or partly within influence zones 1 and/or 2 of Figure 1).

    ii. Above Bankfull- No part of the LWD is within the area that would be occupied by a bankfull discharge event (entirely within influence zones 3 and/or 4 of Figure 1). Also, it is not so far above the bankfull discharge level that it is implausible that a moderate flood discharge would be affected by the piece of LWD.

  b. Length of the main stem of the LWD.
    i. 1.5 m - 5 m.
    ii. 5 m - 15 m.
    iii. Greater than 15 m.
  c. Diameter of the large end of the main stem of the LWD.
    i. 0.1 m - 0.3 m.
    ii. 0.3 m - 0.6 m.
    iii. 0.6 m - 0.8 m.
    iv. Greater than 0.8 m.

3. Repeat steps 1 and 2 for the remaining cross-section transect pairs, recording the data in the appropriate columns of the datasheet for each transect pair.

Substrate Cross-sectional Information

At the top of the Physical Habitat Characterization form, record the site ID, stream name, and sampling date. Also, indicate the cross-section transect that is being examined by placing an "X" in the appropriate box. At the transect, extend the metric tape (use the Stadia rod if preferred) across the channel perpendicular to the flow, with the "zero" end at the left bank (facing downstream).

1. Divide the wetted channel width by four to locate substrate measurement points on the cross-section (0%, 25%, 50%, 75%, and 100% of the total distance as shown in Figure 2 correspond with the "Left," "Left Center," "Center," "Right Center," and "Right" designations in the "Substrate Cross-sectional Info" portion of the Physical Habitat Assessment datasheet, respectively).
2. Depth measurements at the right and left bank will always be 0 (zero), regardless of bank angle or undercut. This is done to prevent repetitive zeroes in the dataset that would negatively skew the average depth calculated for the sample reach. Zeros should already be entered into the spaces for left and right bank depth measurements on the datasheet. Depth should be measured using a meter stick and recorded for the "Left Center," "Center," and "Right Center" locations.

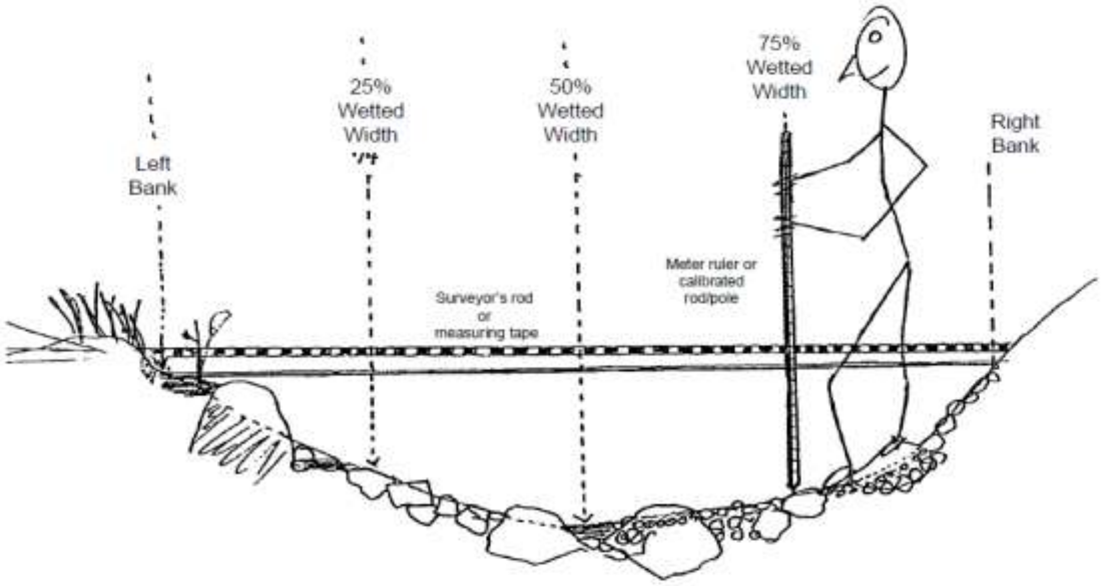


Figure 2. Substrate sampling cross-section schematic.

3. Place your meter stick at the "Left" location (0 m). Pick up the substrate particle that is at the base of the meter stick (unless it is bedrock or boulder) and visually estimate its particle size, according to the Table 1. Classify the particle according to its "median" diameter (the middle dimension of its length, width, and depth). Record the size class code on the field data form. (Note that NA indicates that the substrate has no size range.)

Table 1. Size dimensions and codes for substrate characterization.

Code	Size Class	Size Range (mm)	Description
RS	Bedrock (Smooth)	>4000	Smooth surface rock bigger than a car
RR	Bedrock (Rough)	>4000	Rough surface rock bigger than a car
HP	Hardpan	NA	Firm, consolidated fine substrate
BL	Boulders	>250 to 4000	Basketball to car size
CB	Cobbles	>64 to 250	Tennis ball to basketball size
GC	Gravel (Coarse)	>16 to 64	Marble to tennis ball size
GF	Gravel (Fine)	> 2 to 16	Ladybug to marble size
SA	Sand	>0.06 to 2	Smaller than ladybug size, but visible as particles- gritty between fingers
FN	Fines	<0.06	Silt/Clay/Muck (not gritty between fingers)
WD	Wood	NA	Wood & other organic particles
OT	Other	NA	Concrete, metal, tires, car, bodies etc. (describe in comments)

4. Evaluate substrate embeddedness as follows at 11 transects (A-K). Embeddeness is the fraction of a substrate's surface that is surrounded by fines or sand. For particles larger than sand, examine the surface for stains, markings, and algae to estimate coverage. For

example, if stain encircles the substrate so that only 20% was exposed, use this as evidence in your estimation of 80% embeddeness. Estimate the average percentage embeddedness of particles in the 10 cm circle around the measuring rod. Record this value on the field data form. By default, "sand" and "fines" are embedded 100 percent; bedrock and hardpan are embedded 0 percent.

5. Move successively to the next location along the cross-section. Repeat steps 3 through 6 at each location.
6. Repeat steps 1 through 6 at each new cross-section transect.

Bank Measurements

1. To measure bank angle, lay the meter stick down against the left bank (determined as you face downstream), with one end at the water's edge. Lay the clinometer on the meter stick and read the bank angle in degrees from the **external scale** on the clinometer. Record the angle in the field for the left bank in the "Bank Measurement" section of the Physical Habitat Assessment form.
   a) A vertical bank is 90 degrees; undercut banks have angles >90 degrees approaching 180 degrees and more gradually sloped banks have angles <90 degrees. To measure bank angles >90 degrees, turn the clinometer (which only reads 0 to 90 degrees) over and subtract the angle reading from 180 degrees.
2. If the bank is undercut, measure the horizontal distance of the undercutting to the nearest 0.01 m. Record the distance on the field data form. The undercut distance is the distance from the water's edge out to the point where a vertical plumb line from the bank would hit the water's surface. Measure submerged undercuts by thrusting the rod into the undercut and reading the length of the rod that is hidden by the undercutting.
3. Repeat steps 1 and 2 on the right bank.
4. Visually estimate the channel incision as the height up from the water surface to elevation of the first terrace of the valley floodplain (Figure 3). Record this value in the "Incised Height" field of the bank measurement section on the field data form.
5. Examine both banks to visually estimate and record the height of bankfull flow above the present water level (Figure 3). Look for evidence on one or both banks such as:
   a) An obvious slope break that differentiates the channel from a relatively flat floodplain terrace higher than the channel.
   b) A transition from exposed stream sediments to terrestrial vegetation.
   c) Moss growth on rocks along the banks.
   d) Presence of drift material caught on overhanging vegetation.
   e) Transition from flood- and scour-tolerant vegetation to that which is relatively intolerant of these conditions.

   NOTE: The Field Crew Leader should discuss the evidence of what constitutes bankfull height with the field crew. Identification of bankflow level during baseflow conditions "requires judgment and practice; even then it remains somewhat subjective" (Peck et al. 2006). To assist in this determination, look for slope breaks that denote a floodplain and also look at the vegetative growth; most bankfull flows occur often enough to scour out vegetation. Well established and older riparian growths are obvious indicators of being outside the bankfull zone. A discussion of the available evidence at each site will assist in consistency between these measures and the Large Woody Debris counts, which also rely on identification of the bankfull height.

6. Record the wetted width value determined when locating substrate sampling points in the "Wetted Width" field in the bank measurement section of the field data form. Also, determine the bankfull channel width and the width of exposed mid-channel bars (if present).
7. Repeat steps 1 through 6 at each cross-section transect. Record data for each transect on a separate field data form.

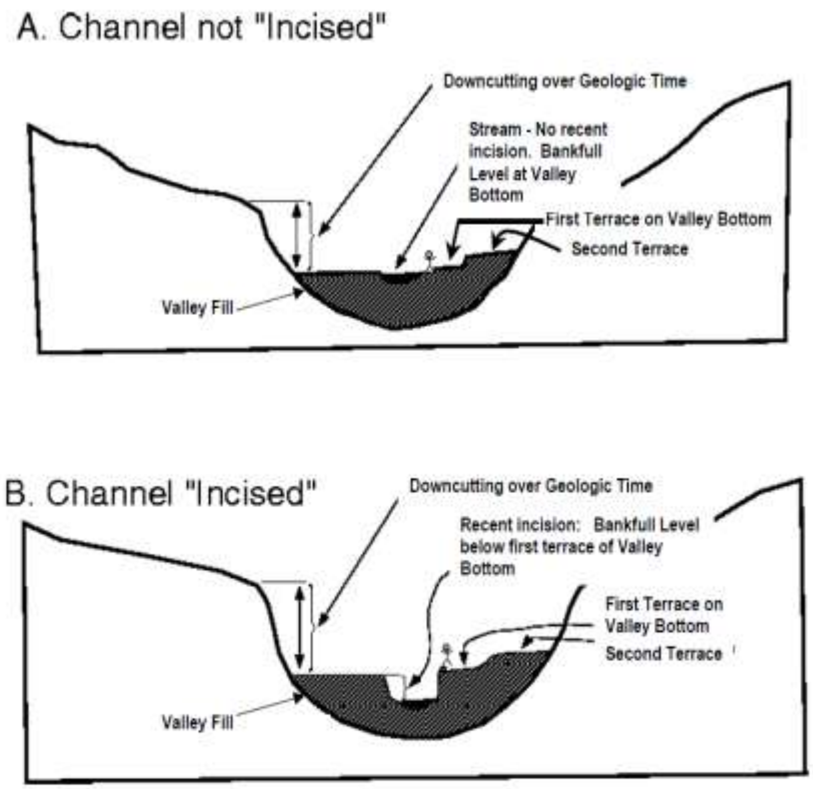


Figure 3. Schematic showing bankfull channel and incision for channels. (A) not recently incised, and (B) recently incised into valley bottom. "Recent incision" indicated on (B) is the distance to be measured and recorded as "incised height" on the field data form. Note level of bankfull stage relative to elevation of first terrace on valley bottom (stick figure included for scale).

Canopy Cover

1. At each cross-section transect, stand in the stream at mid-channel and face upstream.
2. Hold the densiometer 1 m above the surface of the stream. Hold the densiometer level using the bubble level. Move the densiometer in front of you so your face is just below the apex of the taped "V" (Figure 4).
3. Count the number of grid intersection points within the "V" that are covered by a tree, a leaf, or an overhanging branch. Record the value (0 to 17) in the "CENUP" field of the canopy cover measurement section of the Channel/Riparian Cross-section and Thalweg Profile form.
4. Face toward the left bank (left as you face downstream). Repeat steps 2 and 3, recording the value in the "CENL" field of the field data form.

5. Repeat steps 2 and 3 facing downstream and again while facing the right bank (right as you look downstream). Record the values in the "CENDWN" and "CENR" fields of the field data form.
6. Repeat steps 2 and 3 again, this time facing the bank while standing first at the left bank, then the right bank. Record the values in the "LFT" and "RGT" fields of the field data form.
7. Repeat steps 1 through 6 at each cross-section transect. Record data for each transect on a separate field data form.

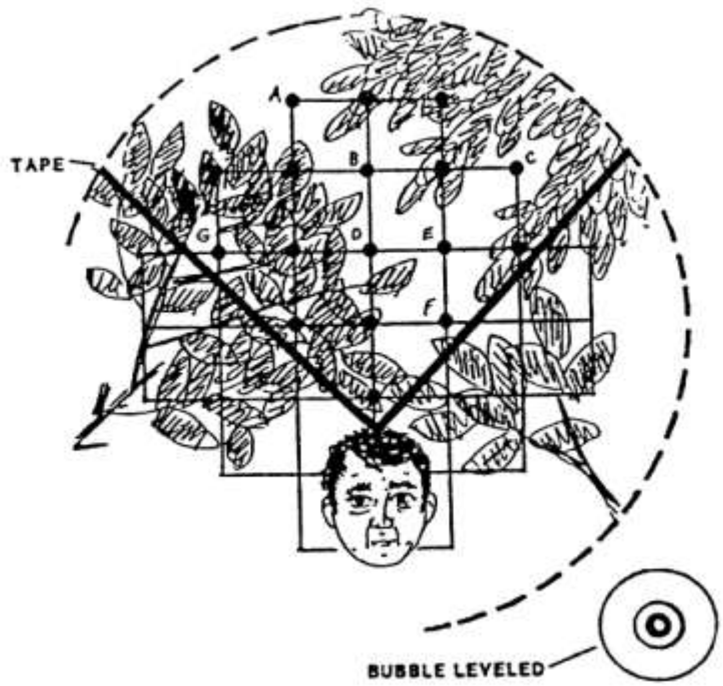


Figure 4. Schematic of modified convex spherical canopy densiometer (from Mulvey et al.1992). In this example, 10 of the 17 intersections show canopy cover, giving a densiometer reading of 10. Intersections not showing canopy cover are indicated with letters A-G. Note proper positioning with the bubble leveled and face reflected at the apex of the "V."

Fish Cover

1. Standing mid-channel at a cross-section transect, estimate a 5 m distance upstream and downstream (10 m total length; Figure 5).
2. Examine the water and the banks within the 10 m segment of stream for the following features and types of fish cover: filamentous algae, aquatic macrophytes, large woody debris, brush and small woody debris, in-channel live trees or roots, overhanging vegetation, undercut banks, boulders, and artificial structures.
3. For each cover type, estimate the areal cover. Record the appropriate cover class in the "Fish Cover/Other" section of the Physical Habitat Characterization form ("0"=absent: zero cover; "1"=sparse: <10%; "2"=moderate: 10-40%; "3"=heavy: 40-75%; or "4"=very heavy: >75%).
4. Repeat steps 1 through 3 at each cross-section transect, recording data from each transect on a separate field data form.

SOP #12: Physical Habitat Characterization (continued).

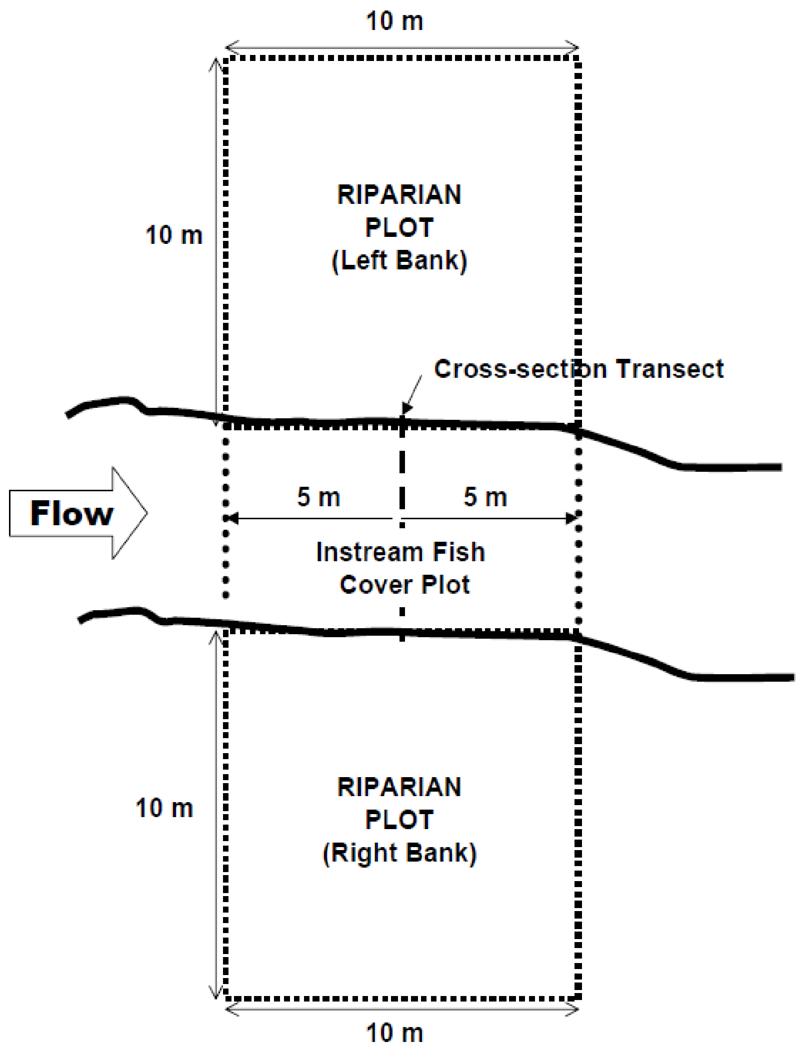


Figure 5. Boundaries for visual estimation of riparian vegetation, fish cover, and human influences.

Visual Riparian Estimates

1. Standing in mid-channel at a cross-section transect, estimate a 5 m distance upstream and downstream (10 m total length; Figure 5).
2. Facing the left bank (left as you face downstream), estimate a distance of 10 m back into the riparian vegetation.
3. Within this 10 m × 10 m area, conceptually divide the riparian vegetation into three layers: a Canopy Layer (>5 m high), an Understory (0.5 to 5 m high), and a Ground Cover layer (<0.5 m high).
4. Within this 10 m × 10 m area, determine the dominant vegetation type for the Canopy layer (vegetation >5 m high) as either Deciduous, Coniferous, broadleaf Evergreen, Mixed, or None. Consider the layer "Mixed" if more than 10% of the areal coverage is made up of the alternate vegetation type. If Mixed is chosen, indicate which other categories are present to constitute "Mixed." Indicate the appropriate vegetation type in the "Visual Riparian Estimates" section of the Physical Habitat Characterization form.

SOP #12: Physical Habitat Characterization (continued).

5. Determine separately the areal cover class of large trees (>0.3 m [1 ft] diameter at breast height [DBH]) and small trees (<0.3 m DBH) within the canopy layer. Estimate areal cover as the amount of shadow that would be cast by a particular layer alone if the sun were directly overhead. Record the appropriate cover class on the field data form ("0"=absent: zero cover; "1"=sparse: <10%; "2"=moderate: 10-40%; "3"=heavy: 40-75%; or "4"=very heavy: >75%).
6. Look at the Understory layer (vegetation between 0.5 and 5 m high). Determine the dominant vegetation type for the understory layer as described in step 4 for the canopy layer.
7. Determine the areal cover class for woody shrubs and saplings separately from non-woody vegetation within the understory, as described in step 5 for the canopy layer.
8. Look at the Ground Cover layer (vegetation <0.5 m high). Determine the areal cover class for woody shrubs and seedlings, non-woody vegetation, and the amount of bare ground present as described in step 5 for large canopy trees.
9. Repeat steps 1 through 8 for the right bank.
10. Repeat steps 1 through 9 for all cross-section transects, using a separate field data form for each transect.

.Human Influence Estimates

1. Standing mid-channel at a cross-section transect, look toward the left bank (left when facing downstream) and estimate a 5 m distance upstream and downstream (10 m total length, Figure 5). Also, estimate a distance of 10 m back into the riparian zone to define a riparian plot area.
2. Examine the channel, bank, and riparian plot area adjacent to the defined stream segment for the following human influences: (1) walls, dikes, revetments, riprap, and dams; (2) buildings; (3) pavement/cleared lot (e.g., paved, graveled, dirt parking lot, foundation); (4) roads or railroads; (5) inlet or outlet pipes; (6) landfills or trash (e.g., cans, bottles, trash heaps); (7) parks, maintained lawns, campsites, or firepits; (8) pastures, rangeland, hay fields, or evidence of livestock; (9) logging; (10) recent wildfires, and (11) mining (including gravel mining).
3. For each type of influence, determine if it is present and what its proximity is to the stream and riparian plot area. Consider human disturbance items as present if you can see them from the cross-section transect. Do not include them if you have to site through another transect or its 10 m ×10 m riparian plot.
4. For each type of influence, record the appropriate proximity class in the “Human Influence” part of the “Visual Riparian Estimates” section of the Channel/Riparian Cross-section Form. Proximity classes are: B (“Bank”) Present within the defined 10 m stream segment and located in the stream or on the stream bank; C (“Close”) Present within the 10 × 10 m riparian plot area, but away from the bank; P (“Present”) Present, but outside the riparian plot area; and O ("Absent”) Not present within or adjacent to the10 m stream segment or the riparian plot area at the transect.
5. Repeat steps 1 through 4 for the right bank.
6. Repeat steps 1 through 5 for each cross-section transect, recording data for each transect on a separate field form.